Magnetic dynamic birefringence in a viscoelastic ferrocolloid

Райхер Ю. Л.[1], Русаков В. В.[1]

[1]*Institute of Continuous Media Mechanics, Russian Academy of Sciences, Ural Branch, Perm, 614068, Russia*

Электронная почта ответственного автора: raikher@icmm.ru

A model is developed to describe the oscillations of optical anisotropy induced in a viscoelastic ferrocolloid (nanodispersion of magnetic particles) by an AC magnetic field. The viscoelasticity of the matrix (carrier medium) is assumed to obey the Jeffreys rheological scheme, whose advantage is that with the aid of just two viscous parameters and a single one for elasticity, it enables one to vary the retarded mechanical response of the carrier from a weakly Maxwellian fluid to a medium with the rheology of a Kelvin gel.

As the orientational motion of the particles driven by the AC field is always strongly affected by thermal motion, the occurring process is described with the aid of a kinetic (Fokker-Planck type) equation that combines the diffusional and drift terms. On this basis, and exact evolution equation for the macroscopic optical anisotropy of a ferrocolloid is derived that is, however, just one link in an infinite chain of equations for statistical moments.

The solution is obtained by applying effective field approximation, i.e., reducing the set of moment equations to their minimally sufficient number. This solution is substituted to the scheme of a standard polarimetric setup, and it is demonstrated, how the peculiarities imparted by viscoelasticity should manifest themselves in the behaviour of intensity of the light beam transmitted through the setup containing a sample of viscoelastic ferrocolloid (Fig. 1).

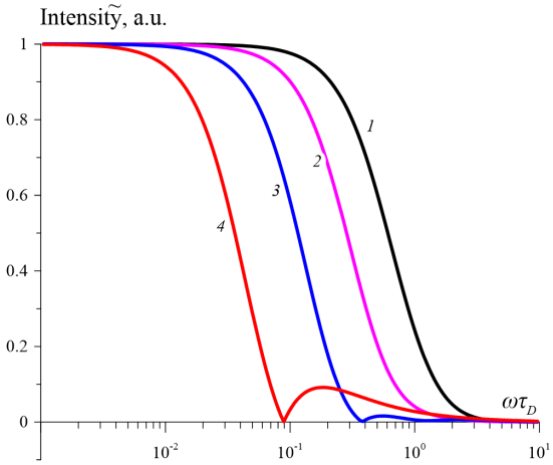

Fig. 1 The plot below demonstrates the effect of viscoelasticity on the intensity of the second harmonic of the light transmitted through a standard polarimetric measuring setup. The extent of viscoelasticity grows from zero for curve 1 to a moderately high level for curve 4